PCT/GB2003/004082

MICROWAVE APPLICATOR

Technical Field

This invention relates to a microwave applicator suitable for heating biological tissue and a method of heat treating surface tissue.

The applicants have previously proposed a microwave applicator for surgical use comprising a waveguide of reduced diameter by virtue of containing a dielectric of high permittivity. A coaxial electrical input generates microwaves in the TE_{11} mode within the dielectric and these radiate from the distal end face of the waveguide.

Disclosure of the Invention

According to a first aspect, the present invention, consists in a microwave applicator comprising a coaxial electrical input and a waveguide filled with dielectric, a central conductor of the coaxial input extending longitudinally within one end of the waveguide to launch microwaves preferably in the TM_{01} mode, to travel to the distal end face of the waveguide so that microwaves are transmitted from the distal end face when in contact with the biological tissue to be treated.

The TM_{01} mode is preferred because it has a field pattern that is a good match with the coaxial input, better than the fundamental TE_{11} mode more commonly used. The TM_{01} also produces a simple transition between the coaxial input and the waveguide. The central conductor is preferably coaxially aligned within a circular waveguide and extends a short way within the waveguide to match the general dimensions of the waveguide, especially its length and diameter, and the permittivity of the dielectric and frequency of the electrical input.

The distal end face of the waveguide is preferably flat and radiates microwave energy with parallel wavefronts that advance into the biological tissue in contact with the distal end face and have minimum lateral spreading. The depth of penetration of the microwaves is dependent upon the frequency and electrical input power, but typically only a small distance of penetration is required for local heat treatment of tissue in microsurgery. In an

CLAIMS

1. A microwave applicator comprising a coaxial electrical input (4) and a waveguide (1) filled with dielectric (2), an inner conductor (7) of the coaxial input (4) extending longitudinally within one end of the waveguide (1) to launch microwaves mode to travel to the distal end face (8) of the waveguide (1) so that microwaves are transmitted when the distal end face (8) is contacted by biological tissue to be treated.

2. A microwave applicator as claimed in claim 1 in which the inner conductor (7) is axially aligned with the waveguide (1).

3. A microwave applicator as claimed in claim 1 or 2 in which the waveguide (1) is a circular waveguide.

4. A microwave applicator as claimed in any one of the preceding claims in which the distal end face (8) is substantially flat and normal to the axis of the waveguide (1).

5. A microwave applicator as claimed in any one of claims 1 to 3 in which the distal end face (8) is flat or slightly domed and centred on the axis of the waveguide (1).

6. A microwave applicator as claimed in any one of the preceding claims in which the distal end face (8) has a polymer coating (22).

7. A microwave applicator as claimed in any one of the preceding claims in which the length and diameter of the waveguide (1), the length of the inner conductor (7) within the waveguide, and the permittivity of the dielectric material (2) are selected so that at the designed operating frequency, the waveguide is in resonance.

8. A microwave applicator as claimed in any one of the preceding claims in which the waveguide (1) is adapted so that in operation, when the distal end face (8) is in contact with biological tissue to be treated, forwards transmission from the distal end face is enhanced by the relative phase of reflections from the distal end face (8) and the input (4) to the waveguide; and when the distal end face (8) is in air or gas,

reflections to the input (4) are enhanced by the relative phase of reflections from the distal end face (8) and the input (4) to the waveguide.

9. A microwave applicator comprising a waveguide (1), a coaxial electrical input (4) with an inner conductor (7) extending longitudinally within one end of the waveguide to launch microwaves in the TM_{01} mode that travel to the distal end (8) of the waveguide and are transmitted into biological tissue to be treated, a diaphragm (20) of low loss dielectric material being provided within the waveguide (1) so as to extend laterally of the waveguide to reflect the microwaves travelling along it, the longitudinal location of the diaphragm (20) being selected in relation to the ends of the waveguide (1) so that the phase of reflections from the diaphragm (20) and said ends serve to reduce or cancel rearward reflections in the coaxial input (4).

10. A microwave applicator as claimed in claim 9 in which the thickness of the diaphragm (20), and the permittivity of the dielectric material from which it is made are selected to determine the magnitude of the rearward reflection of microwaves from the diaphragm (20) for optimum cancellation of the rearward reflection in the coaxial input.

11. A microwave applicator as claimed in claim 9 or 10 which is air-filled.

12. A microwave applicator as claimed in any one of the preceding claims in which the waveguide launches microwaves in the TM_{01} mode.

13. A method of heat treating surface tissue using the microwave applicator of any one of claims 1 to 12 in which the end face (8) of the waveguide (1) is brought into contact with the surface tissue.

14. A method as claimed in claim 13 in which the surface tissue is internal tissue and the applicator is inserted into a body for treatment.

15. A method as claimed in claim 14 in which the insertion of the applicator is via a Trocar.

16. A method as claimed in claim 13 in which the surface tissue is the external skin of the body.

17. A method of treating a liver in a body comprising providing a microwave applicator having a treatment head at one end capable of emitting microwave radiation from an emitting face, inserting the microwave applicator through an incision into the body positioning the head of the microwave applicator in contact with a surface of the liver with the emitting face adjacent to a region to be treated, and powering the microwave applicator so that the emitting face emits microwave radiation that heats said region to be treated.

18. A method of treating biological tissue to stop bleeding comprising providing a microwave applicator having a treatment head at one end capable of emitting microwave radiation from an emitting face, positioning the head of the microwave applicator in contact with a surface of the biological tissue to be treated with the emitting face adjacent to bleeding tissue to be treated, and powering the microwave applicator so that the emitting face emits radiation that heats the bleeding tissue to be treated.

19. A method of treating a skin condition such as psoriasis using a microwave applicator having a microwave emitting window which is brought into contact with, or into close proximity of, skin to be treated and is powered so as to emit microwave radiation and irradiate the skin to be treated.